GREEN GDP AS AN INDICATOR OF EVIRONMENTAL COST OF ECONOMIC GROWTH IN UKRAINE

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ABSTRACT. The article provides the results of the environmental adjustment of the traditional macroeconomic indicators for Ukraine taking into account depletion of natural capital, environmental degradation due to atmospheric pollution and governmental expenditures on environmental protection. For the first time the calculation of "Green GDP" and environmentally adjusted net domestic product (NDP) for Ukraine has been elaborated for the period 2001-2010. Depletion of natural capital has been estimated based on the official data on the net operational income and specific taxes of the extraction industry of Ukraine and applying the Hartwick's rule on the reinvestment of the resource rent. Environmental degradation due to atmospheric pollution has been estimated based on the results of the research on the economic cost of pollution from thermal power stations in Ukraine. The general conclusion is that the economic growth of Ukraine is significantly dependent on natural capital and has substantial environmental drawbacks.

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1. INTRODUCTION

Economic growth and increasing anthropogenic pressure on the environment during recent decades have brought to light the double sided and complex dependence of the economy and the environment. Growth of production outputs created demand for increased consumption of resources and energy and consequently increased the anthropogenic pressure on natural environment. Simultaneously it could bring more financial resources for environmental protection activities, while increased equity of resource allocation could further improve environmental conditions. On the other hand, the state of natural environment can either boost an economic activity in some specific regions or cause a recession and additional expenses for health protection and cleaning of the environment.

Such complex inter-linkages between the economy and the environment demand the establishment of a comprehensive information system for in-depth analysis and mainstreaming sustainability into decision-making of governments, businesses and general public leading to more sustainable and greener economy.

The purpose of this study is to present the calculation of environmentally adjusted macroeconomic indicators for Ukraine and analyze the environmental cost of economic growth of Ukraine.

We explore the “Green GDP” concept and methodological approaches for adjusting gross domestic product to account for natural resource depletion and environmental degradation. We also present the results of calculation of environmentally adjusted net domestic product and “Green GDP” for Ukraine for the years 2001-2010.

The remainder of the paper is organized as follows: in section 2 we discuss the main methodological approaches for environmental adjustment of macroeconomic indicators and

explore some examples of “Green GDP” calculation; in section 3 the role of natural capital in the economy of Ukraine is explored; in section 4 we present the methodological algorithm used for calculation of environmentally adjusted macroeconomic indicators of Ukraine and in section 5 we discuss the obtained results. Finally some conclusions are drawn.

2. “GREEN GDP” CONCEPT

GDP as a common used indicator of economic growth and a basis for decision-making and state policy elaboration is not intended to measure human wellbeing even if treated so by politicians and governments. GDP deals only with economic output and does not consider other important factors significantly impacting human well being and sustainable economic growth such as the state of the environment.

The economic growth is definitely important for preserving the environment. However, there are many other factors impacting environmental performance. The research by D.C. Esty and M.E. Porter demonstrated that among low-income countries the variance of environmental performance indicators is particularly high relatively to that of more prosperous countries. This suggests that environmental performance can be substantially improved in many low-income countries, independent of the gains that come with economic development. Among the factors influencing environmental performance the quality of environmental regulatory regime in place and its enforcement, lack of environmentally harmful subsidies, following the rule of law, elimination of corruption and strength of state’s governing structures appear to be significant (Esty *et al.*, 2005).

In turn, environmental regulatory regime and environmental policy should be guided by appropriate indicators, which take into consideration both economic and environmental factors, to ensure the green and sustainable path of country’s development and transition to a green economy. Such information framework should be a basis for communication of innovative environmental-economic researches and policy options to decision makers and

political leaders and for the education of public. Given that at present, as reasonably indicated by Paul R. Ehrlich, "…ecological economists do not take their concerns and research conclusions to decision makers and the general public with nearly the force that is needed. This allows the false view to persist that economics has little of interest to contribute to solving the human predicament" (Ehrlich, 2008).

Under the traditional system of national accounts and traditional methods for calculation of gross domestic product consumption of natural capital and environmental degradation are not taken into account in a proper way.

That is why more and more countries and international organizations are pushing forward creation of more reliable indicators of sustainable economic growth by extending the traditional system of national accounts to account for natural capital losses. One of the approaches applied is the calculation of environmentally adjusted macroeconomic aggregates.

Such green macroeconomic indicators (i.e. environmentally adjusted net national product, environmentally adjusted net domestic product, "Green GDP", eco-domestic product, etc.) were calculated for at least a dozen of countries. However, most of the estimations made were undertaken as research projects but not as official estimations by national statistical authorities.

The studies differ in the initial statistical data analyzed, the number of natural capital factors taken into account in the estimates and also in the methodological approaches taken to determine the level of influence of environmental parameters on the traditional indicators of the system of national accounts (see for instance: Cole, 2011; Skånberg, 2001; Nourry, 2008). However, the analysis of the results of these studies shows the substantial difference between the conventional and environmentally adjusted macroeconomic indicators in all countries, emphasizing the important role of natural capital in the global economy.

Despite the significant development of the environmental accounting in the past two decades, a single method of calculation of environmentally adjusted gross domestic product is still not established. Generally speaking, “Green GDP” is a macroeconomic indicator, which represents the economic results of the interaction of national economy and the environment in the numerical dimension for a certain period of time. The concept of “Green GDP” involves subtracting from traditional GDP the value of consumed natural resources and environmental degradation.

Experts have worked out some common approaches to the methodology of calculation of environmentally adjusted GDP, a combination of which can be applied to practical calculations (UN, 2003). At present, the following main methodological approaches are established.

The first methodological approach of the calculation of environmentally adjusted domestic product includes consideration of the reduction of natural capital, for example, due to mining industry operation. At the same stage an increase in stocks of natural capital due to discovery of new deposits of natural resources or revaluation of previously known reserves can be taken into account.

The second methodological approach takes into account environmental degradation due to accumulation of pollutants and waste, as they not only affect economic activity, but also impact the quality of natural capital, as well as human health, which should be properly displayed in the main indicators of development of a country.

The third methodological approach in the calculation of “Green GDP” supposes further deduction of the costs spent on combating environmental degradation. Indeed, expenditures on environmental protection, which in the traditional system of national accounts are included in final consumption, should be displayed in environmentally adjusted national accounts depending on their impact on natural capital. In other words, since these costs are

intended to improve the state of a particular natural capital, they must be deducted during the calculation of environmentally adjusted gross domestic product and moved from the category of end-use to the category of intermediate consumption, while the economic effect of such expenses (if it can be estimated) should be added to this figure.

Therefore, the methodological algorithm of the general scheme of the calculation of environmentally adjusted GDP could be presented as follows:

$$\text{“Green GDP”} = GDP - CNR - ED - EPE$$

where,

“Green GDP” – environmentally adjusted gross domestic product,

GDP – gross domestic product,

CNR – consumption of natural resources (decrease of natural resources stocks),

ED – environmental degradation (environmental harm due to economic activity),

EPE – environmental protection expenditures.

It should be noted, that in the similar way the environmentally adjusted net domestic product could be calculated by deducting fixed capital consumption, which is the standard procedure for the system of national accounts.

Taking into account the fact that after decades of research developing of statistically accurate estimate of “Green GDP” is still challenging, some countries like Norway and Germany resisted official use of “Green GDP” concept (Rauch *et al.*, 2010). There is an opinion, that it is not correct for the statistical accountants to take controversial decisions about the value of environmental assets and to incorporate such decisions, and to some extent conceal them, in apparently neutral information about the trend in an environmentally adjusted GDP. Such information should instead be presented by way of analyses whose assumptions and suppositions are clearly presented and discussed (Alfsen *et al.*, 2007).

However, others countries like UK, China, Vietnam and India are making first steps for the introduction of “Green GDP” into national statistical systems.

United Kingdom has established Natural Capital Committee, which is designed to provide independent expert advice on the state of country’s natural capital and environment-economic policy. Among the future tasks of the Committee will be the development of green national accounting framework – GDP plus, which would take proper account of the value of natural capital in government accounts. According to UK’s Environment Secretary Caroline Spelman, a country can drive significant greening if it takes proper account of the value of natural capital in government accounts[1].

China was probably the only country as for now, which has published official reports on “Green GDP” on the national level.

The “Green GDP” accounting research project was launched in China in March 2004. The first “Green GDP” accounting study ("China Green National Accounting Study Report 2004") was released in September, 2006 jointly by the State Environmental Protection Administration of China (SEPA) and the National Bureau of Statistics of China (NBS). The report was first of its kind on environmentally adjusted GDP accounting in China. According to the report in 2004 economic losses due to certain types of environmental pollution caused negative economic effect equal to 511.8 billion yuan or 3.05% of country’s GDP. Economic losses due to pollution of water resources, atmospheric air, solid waste placement and sporadic incidents of economic activities that lead to environmental pollution were considered in the report. Soil and groundwater contamination and depletion of natural resources stocks were not taken into account due to lack of data and lack of sufficiently

[1] From the “Secretary of State’s speech on the UK aims for Rio+20” available at http://www.defra.gov.uk/news/2012/02/09/caroline-spelman-on-uk-aims-for-rio20/

developed methodological approaches. In addition, the cost of cleaning the air and water resources was estimated at 1.8% of GDP (287.4 billion yuan)[2].

The second "Green GDP" report was prepared by SEPA, but NBS has refused to publish it arguing that the estimation methods were inaccurate. However, it is widely believed that pressures from some government officials' concern over high economic costs played an important role (Liu *et al.*, 2008). While Mr. Pan Yue, Vice Minister of the SEPA, initially claimed that a framework for the "Green GDP" accounting system would come into effect within three to six years, becoming the benchmark for governmental officials' performance, support for the project was withdrawn in 2007 and the project was officially cancelled in 2009 (Rauch *et al.*, 2010).

Finally, in 2012 the results of the third report on estimation of China's "Green GDP" have been made publicly available. Chinese Academy of Environmental Planning has released the results of the research project undertaken by the joint task force of the Ministry of environmental protection and Chinese scientific institutions with environmental and economic accounting data for the year 2009. According to the report environmental degradation costs and ecological damage costs accounted in 2009 for 1.39162 trillion yuan representing an increase of 9.2 percent over the previous year.[3] Taking into account official data on China's GDP for 2009 equal to 34.0903 trillion yuan[4] the environmental degradation costs and ecological damage costs accounted for about 4% of GDP in 2009. Therefore, the "Green GDP" for China in 2009 was 4% lower than traditionally estimated GDP. The environmental cost of economic growth has grown both in absolute and relative terms in comparison to the year 2004.

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[2] As reported by Chinese Government's Official Web Portal. See 'Green GDP Accounting Study Report 2004 issued' at http://www.gov.cn/english/2006-09/11/content_384596.htm published on September 11, 2006.

[3] As reported by Chinese Academy of Environmental planning. See http://www.caep.org.cn/ReadNews.asp?NewsID=3105

[4] See the Announcement of National Bureau of Statistics of China No.1 2011 available at http://www.stats.gov.cn/english/newsandcomingevents/t20110112_402697807.htm

Vietnam is currently also in the process of developing a "green" gross domestic product index, which under Prime Minister's Decision would be included in the national system of socio-economic indices by 2014. With support from the UK's Foreign Commonwealth Office, Vietnam's Central Institute for Economic Management (CIEM) and the General Statistics Office are conducting the research to develop a methodological framework for a national Green GDP Index. The Green GDP will include the depletion of natural resources and costs of pollution in its calculations[5].

India as well plans to introduce a system of green national accounting till 2015. Acknowledging that "Green GDP" has its limitations as an indicator of sustainability, Jairam Ramesh, Minister of Environment and Forests in the Government of India, assumes it as a useful tool for mainstreaming more sustainable environmental policy: "We do not need precise numbers. Even a broad-brush estimate will be a huge step forward to give practical meaning to the concept of "sustainable development" which all of us swear by in theory" (Ramesh, 2010).

3. NATURAL CAPITAL AND ECONOMIC GROWTH IN UKRAINE

The implementation of the calculation of environmentally adjusted GDP is particularly important and practically valuable for those countries, whose economies are heavily dependent on natural resources, which include Ukraine.

The first years of the 21st century were remarkable for Ukraine's economic history because of the beginning of steady growth of national economy after years of depression. The average rate of GDP growth in Ukraine during the period 2001-2007 was about 7.5%.

[Insert Fig. 1 here]

The level of economic growth was higher than the increase in the amount of natural resources used and the amount of pollution and waste generated by the economy (see Fig. 1).

[5] As reported by Viet Nam News Newspaper on 28th of March, 2012. See "Nation targets green growth" article available at http://vietnamnews.vnagency.com.vn/Industries/222756/nation-targets-green-growth.html

However, such increase in economic activities was to a high degree predetermined by preceding economic recession during the last decade of 20th century, when GDP declined by more than 50%. Nevertheless, the strong positive correlation exists between economic growth and energy consumption (94%) as well as air pollution (91%). Moreover, significant positive correlation appears between economic growth and waste creation (65%) as well as wood resources consumption (64%).

Thus, it could be concluded that natural capital plays an important role in the economy of Ukraine, which is still very energy and resource intensive. The share of gross value added of the mining industry in GDP during 2001-2010 was on average equal to 4.5%; the share of electricity, water and gas production and supply sector was on average equal to 3.9%; the share of agriculture, hunting and forestry sector was on average equal to 9.4%; and the share of fishing and fishery sector was on average equal to 0.04% of GDP. The share of mineral products in overall country's export as for 2010 was 13.1%, the share of forestry products was about 1.6% and the share of metal products was as high as 33.7%[6]. According to the National Report on the State and Perspectives of National Energy Efficiency Policy in 2008 energy intensity of GDP in 2008 was 0.46 kg of oil equivalent per USD of GDP, which is more than two times higher than in developed countries (Yermilov *et al.*, 2009).

It is officially acknowledged that about 15 percent of the territory of Ukraine with the population of above 10 million people is in critical environmental condition. Herewith, the share of arable land, the level of water consumption and the level of deforestation in Ukraine are the highest in Europe, and the anthropogenic and industrial pressure on the natural environment is several times higher than in developed countries and continues to grow.

The structure of agricultural lands, just like the structure of Ukraine's land fund, is characterized by a very high index of agricultural development (72%). Ukraine has a very

[6] All data have been calculated based on official reports of State statistical committee of Ukraine

high level of cultivated land, significantly exceeding the ecologically justified limit. Water resources are distributed very unequally within the country's territory. As a result, river flows are highly regulated. Regulating the flow of the majority of rivers has reached, and even exceeded, the top-end economic- and ecology-based permissible limits. Such regulation has drastically decreased and often completely destroyed rivers' capacity to self-purification. Ukraine's forestation amounts to 15.6% of total land area, while the State "Ukraine's Forests for 2002-15" Program defines optimal forestation for Ukraine as 19-20% and some researchers, meanwhile, believe optimal forestation should be around 25% (UNDP Ukraine, 2007).

Therefore, current development path of Ukraine's economy could hardly be called sustainable as economic growth is accompanied by inefficient consumption of resources, depletion of natural capital and environmental pollution.

Thus, an integrated environmental economic information and management system is highly important for Ukraine for proper analysis of natural capital role in national economy development.

4. DATA AND METHODOLOGY USED

Following the general procedure described in Section 1 and using available statistical data we have calculated the environmentally adjusted macroeconomic indicators for Ukraine.

Thus, the first approach of "Green GDP" and environmentally adjusted NDP calculation methodology foresees the estimation of the value of natural capital reduction. Given the limited sources of statistical data and taking into account the degree of importance of various natural resources in the economy of Ukraine, the consumption of natural capital was estimated based on the economic data of mining industry, which includes the following economic activities: mining of coal, lignite and peat; extraction of uranium and thorium ores;

extraction of hydrocarbons and related services; extraction of other minerals that are not related to energy resources.

Currently existing system for accounting of economic activity of enterprises (an accounting system at the enterprises' level and a system of national accounts at the level of industries and the economy in general) can clearly distinguish from gross income only consumption of fixed capital, whereas the remaining components (income from the use of fixed capital and income from the use of natural capital) automatically fall into the category of net income or just not considered at all (consumption of natural capital). Therefore, this approach does not take into account the shortage of natural resources, which becomes increasingly important factor in the economic development, and virtually ignores the role of natural capital in the long-term growth.

The benefits coming from the use of natural resources, can be equated with economic rent, which is embodied in gross operating surplus of an enterprise, and can be partitioned into two parts, one part relating to the economic rent coming from the use of produced assets (fixed capital) and the other part due to the use of non-produced assets (natural resources). The term resource rent is used for this second element, that part of gross operating surplus of the enterprise using the resource which is not attributable to the fixed capital (UN, 2003).

Thus, taking into account the crucial role of natural capital and specifically exhaustible natural resources in economic development and human well-being gross income of the mining industry should be considered at least as a sum of economic rent on fixed capital and resource rent. However, in case of the mining industry of Ukraine, which is characterized by high level of fixed capital deterioration (reaching 53% in 2008) and low net operating surplus to fixed capital ratio (4.3% on average for 2001-2007, which is even lower than in other industries not dealing with resource extraction), the return on fixed capital is ignored and it is

assumed that income is gained only due to exploitation of natural resources and consumption of fixed capital.

Therefore, we would further use net operating surplus values for the mining industry of Ukraine and specific taxes for the mining industry as an estimate of resource rent of the mining industry, which reflects the economic evaluation of natural capital consumption. The term “specific taxes” refers here to those taxes on production, which can be specifically identified with extracting industry. Addition of these “specific taxes on production” provides a measure of the full resource rent derived from national reserves, whatever the units/institutional sectors (non-financial corporations or general government) that appropriate the rent (Eurostat, 1999).

In our opinion, it would be methodologically correct to partition resource rent into a part representing decline in the value of natural resources (consumption of natural capital) and a part representing the return on use of natural resources.

We will apply the Hartwick’s rule for this purpose. According to the Hartwick’s rule during the estimation of the natural capital stocks reduction due to economic activities it is assumed that all amount of resource rent gained by consumption of exhaustible natural resources is reinvested and the whole volume of such investments except the income from them is treated as the reduction of the value of natural capital (Hartwick, 1977). The input of the non renewable natural capital in social production will be the income from the new capital assets, in which the income from natural capital consumption would have been invested (Skånberg, 2001).

Based on the fundamental considerations presented above and taking into account specifics of economic activities of the mining industry, we made the following three steps to calculate partially environmentally adjusted for the depletion of natural resources NDP.

The first step. Based on official statistical data for the period 2001-2010 we calculated the sum of net operating income of the mining industry (which for this industry is assumed to be

gained only due to exploitation of natural resources) and specific taxes for the mining industry.

The second step. Based on the rate of alternative cost of capital we estimated potential (hypothetical) income from the investment of capital derived from the exploitation of natural resources in other activities. Alternative cost of capital is a number that reflects the expected rate of return on investments in other (alternative) economic activities rather than investing in extraction of natural resources and is based on the expected rate of return.

It is worth mentioning, that for evaluation of the income from fixed capital the experts of Eurostat recommend for the European countries to use the value of the rate of return (opportunity cost of capital) equal to 8% if there is no more precise estimates (default value) (Eurostat, 1999). Taking into account the fact, that fixed capital of the mining industry in Ukraine (and for the industry in general) is characterized by a high level of depreciation (the degree of depreciation in the mining industry during 2000-2008 increased from 41.8% to 52.9%) during the calculation of partially environmentally adjusted net domestic product the value of the rate of return equal to 5% was used (which is close to the average ratio of net income to the cost of fixed assets for the industrial sector excluding the mining industry).

The third step. Further we subtracted from the traditional NDP indicator the amount of net operating income of the mining industry and specific taxes/fees, and added a potential income from the investment of capital derived from the exploitation of natural resources in other activities.

We used the data on national domestic product and economic performance of mining industry obtained from national accounts of Ukraine and data on specific taxes of the mining industry of Ukraine obtained from the state's budgets of Ukraine. All data are measured in Ukrainian hryvnas (national currency) and the results of calculation were converted to US

dollars using annual average currency conversion rates according to the data of National Bank of Ukraine.

As the result of performed calculations the dynamic range of partially environmentally adjusted net domestic product of Ukraine accounting for reduction of natural resources stocks was obtained.

It is worth mentioning, that we have not taken into account new discoveries of natural resources in our calculations. Inclusion of new discoveries can have a huge impact on measured macroeconomic indicators. For example, in some years changes in the total value of Norway's stock of oil have exceeded its GNP. Failure to separate capital gains and losses from depletion is likely to introduce spurious volatility of measured macroeconomic aggregates thereby undermining their credibility as an indicator of economic performance. In studies, where capital gains are included in depletion and affects calculation of environmentally adjusted macroeconomic indicators the results of such adjustment are liable to fluctuate widely and to grow in a manner that may provide no clue as to its sustainability (Hill et al., 1999).

The second approach of "Green GDP" calculation methodology takes into consideration environmental degradation due to accumulation of pollutants and waste. Note that the impact of environmental degradation on the state of natural resources and human health is often not covered by the traditional system of national accounting and in general is difficult to estimate. Such effects may include, for example, reducing the assimilation capacity of the environment and lead to lower ecological rents. Given this, the guidance for building the system of environmental and economic accounts offers a simplified approach based on the assumption that it is excessive formation of pollution affects the quality of the environment and ecological functions it provides. In other words, when assessing the environmental degradation not the cost of clean air or water resources or the value of environmental services

that they can provide are taken into account but monetary evaluation of the damage done as a result of environmental degradation or expenses to be incurred in order to avoid this degradation (UN, 2003).

Monetary evaluation of the cost of pollution abatement is based on the data on emission volumes and specific costs to reduce emissions, or to be more concrete, on the dynamics of specific costs to reduce emissions for different volumes of pollution reduction. In turn, the calculations of environmental degradation based on damage assessment is most often undertaken with regard to the damage done to human health, which is usually determined by the functional dependence “dose – response”, but can also include the assessment of damage to infrastructural objects.

In our study we used the approach, which is based on the assessment of the damage done as a result of environmental degradation. However, due to the lack of initial data on the economy of Ukraine in general, to calculate a partially environmentally adjusted net domestic product by the second approach we have estimated only the impact from emissions of pollutants by thermal power plants of Ukraine on human health.

Here we have used the results of the recent study of economic harm to human health caused by emissions of pollutants as a result of the thermal power plants operation on the example of Trypilska power station. The study was based on an assessment of emissions from the thermal power plant, their circulation in the atmosphere, the concentration in the ground, the impact of pollutants on human health and economic assessment of such damage impact. The health impact of such pollutants as small particles (PM_{10}), SO_2 and NO_x was taken into account based on the functional dependence “dose – response” and data of relevant European researches. As a result of the study the estimate of the specific harm from the production of electricity by thermal power plants equaled UAH 0.3 per kWh was obtained (Matsuki *et al.*, 2010).

The results of this study were used as an approximate estimate of marginal damage from the air pollution from all thermal power plants of Ukraine. Since in our calculations we have used both values of NDP in current prices and constant 2001 prices, so far using the GDP deflator index the value of specific harm from production of electricity by thermal power plants was also calculated in constant 2001 prices and was found to be equal UAH 0.13 per kWh. In our calculations, we used the data of National Electricity Regulation Commission of Ukraine on the amount of electricity sold by thermal power plants to the state's energy market.

The third approach of the methodology for calculating of "Green GDP" takes into account expenditures aimed at protecting the environment and combating environmental degradation.

In this regard we should pay attention to the fact that these expenditures are divided into capital expenditures, which will help to reduce environmental degradation in current and future periods (fixed capital formation), and current expenditures, which are affecting only reduction of environmental degradation in a given period (compensation of employees and intermediate consumption). Capital environmental expenditures are classified as capital accumulation and regardless of the type of entity, which undertakes the expenditures, constitute to final demand and are accounted for in the gross domestic product. As for the current environmental expenditures, it is important to note that these expenditures are referred to as an intermediate consumption and are not included directly in the calculation of GDP. However, when the producer is within the government sector and the production is for collective consumption, the environmental protection expenditures are automatically added to the level of government consumption and thus to the level of GDP. Moreover, even current environmental expenditures of industry indirectly affect the GDP due to transferring the costs on customers (UN, 2003).

To ensure a symmetrical treatment of current environmental protection expenditures of industrial and public sectors the guidance for building the system of environmental and economic accounts proposes some reclassification exercise. Namely, it is proposed to

consider these costs firstly as the fixed capital formation and then as the consumption of fixed capital. This approach will not affect the total output of industry, but will not only increase GDP through consideration of environmental expenditures in fixed capital formation, but also will leave unchanged NDP because the same amount of environmental expenditures will be taken into account in the consumption of fixed capital. Public environmental expenditures will move from the category of final consumption to the category of fixed capital formation without affecting the size of GDP, but reducing the size of NDP because as in the case of industry expenditures the same amount of environmental expenditures will be taken into account in the consumption of fixed capital. As a result, the uniform treatment of environmental expenditures of the state and industry is ensured and the difference between GDP and NDP increases for the entire amount of environmental expenditures, while increasing the volume of GDP at current environmental protection expenditures by industry and reducing the volume of NDP by current government expenditures on environmental needs (UN, 2003).

In our research, we have considered current environmental protection expenditures of the public sector and used the official statistical data on relevant expenditures from the state and local budgets for adjusting traditional domestic product.

5. DISCUSSION OF RESULTS

The current paper presents the results of calculations of environmentally adjusted NDP and environmentally adjusted GDP (“Green GDP”) for Ukraine for the period 2001-2010, which were carried out for the first time among other former USSR countries. Based on very limited statistical data the estimates take into account depletion of natural resource stocks as the result of the mining industry operation, environmental degradation due to air pollution from the thermal power plants operation and current public environmental protection expenditures.

It has been demonstrated, that consideration of consumption of natural resources leads to permanent reduction of the traditional net domestic product of Ukraine during the period 2001-2010. In addition, calculations show that during this period NDP adjusted to account for reduction of natural resources stocks due to economic activity in the mining industry was not only below the traditionally calculated NDP, but also had a slower growth rate. This situation is quite logical because profits from the activities of extractive industry in the traditional national accounts do not take into account reduction of natural resources stocks.

The results of calculations also demonstrate the significant level of harm from air pollution due to electric power generation by thermal power plants, which during the years 2001-2010 ranged at 3 - 4.5% of net domestic product. Thus, consideration of environmental degradation in the form of health impact of emissions from the thermal power plants in Ukraine during calculation of partially environmentally adjusted domestic product leads to the decrease in traditional NDP by 3.6% on average.

It should be emphasized that since the above calculations of partially environmentally adjusted domestic product (by the second methodological approach) take into account only the impact of harmful emissions from the thermal power stations of Ukraine on human health through air pollution, they do not evaluate the magnitude of harm from soil contamination, water pollution and biodiversity loss due to such emissions, thus the underestimation of actual differences between traditional NDP and NDP adjusted to the detriment of air pollution from thermal power plants of Ukraine is evident, despite their remarkably high values.

It is worth mentioning, that the results of our calculations are in line with another results of the estimation of the health losses from urban air pollution in Ukraine. According to these results, Ukraine has considerable health and mortality costs in human and monetary terms associated with air pollution. At a conservative estimate these costs amount to 27,000 excess

deaths annually. In monetary terms, the costs were estimated at around USD 2.6 billion or 4 percent of GDP (Strukova *et al.*, 2006).

According to our estimates, consideration of the impact of the public sector environmental protection expenditures on NDP does not cause significant change in NDP in relevant terms (about 0.03%), however in absolute terms the difference is significant (the average difference for 2001-2010 is USD 26 million in current prices and USD 13 million at constant 2001 prices). In case of the introduction of the environmental-economic accounts and regular monitoring of environmental activities in terms of trends and sources of funding, these calculations can provide important information on the costs of environmental degradation for the state budget and on the extent by which environmental protection expenditures cover damages due to economic activity. This will eventually lead to more accurate calculation of "Green GDP".

It is important that despite the growth in absolute numbers of public environmental protection expenditures in Ukraine during the period under consideration, their share in the total public expenditures on average did not exceed 1%. If compared with GDP, the amount of public environmental protection expenditures will constitute less than 0.1% of GDP, which is very low and is not responding to the high level of environmental problems the number of which in Ukraine has been growing every year.

The overall results of calculations are presented in the table 1 below.

[Insert table 1 here]

The results demonstrate a significant 'environmental cost' of economic growth of Ukraine during the period 2001-2010. The cost of natural capital depletion and environmental degradation has increased almost twofold from UAH 10.1 billion in 2001 to UAH 20.1 billion in 2008 in constant 2001 prices and then decreased to 17.8 UAH billion in 2010 due to economic slowdown. Environmentally adjusted net domestic product during the period 2001-2010 appeared to be on average by 5.70% lower than the traditionally estimated net domestic

product. The difference between traditionally calculated GDP and “Green GDP” during the period 2001-2010 was on average 4.99% or USD 2.393 billion in constant 2001 prices or USD 5.103 billion in current prices. In other words, “Green GDP” of Ukraine on average during the period 2001-2010 constituted to 95% of traditional GDP demonstrating clearly excessive value of the most common used macro-economic indicator. Besides, “Green GDP” of Ukraine has also slightly lower in comparison to traditionally estimated GDP growth rate equal to 3.9% on average during the period 2001-2010 comparing to 4.1% average growth rate of traditional GDP.

6. CONCLUSIONS

Economic growth is important for human well being and also for the environment as growing income often improves environmental performance of the country. However, more detailed and comprehensive analysis with consideration of environmental factors should be undertaken to investigate whether economic growth is really accompanied with improving environmental performance or on contrary leads to significant ecological cost of development.

This paper estimates environmentally adjusted gross domestic product and environmentally adjusted net domestic product for Ukraine for the period 2001-2010.

According to our estimation, the financial losses due to natural capital depletion and the degradation of the environment averaged at about 5% of the national economy during the considered period. Furthermore, as in our calculations of environmentally adjusted GDP the damage from pollution of soil and water, as well as biodiversity losses, have not been evaluated due to the lack of data, thus the actual rate of negative effects of environmental degradation is clearly underestimated and hence the corresponding annual income is on contrast overestimated.

The results should be treated as preliminary and the findings as tentative because not all elements of natural capital depleted and not all negative effects of economic activities on

natural environment were taken into account. More reliable statistical information and more wide approach for inclusion of other elements of natural capital and negative environmental impact of economic development is needed. Areas of further work include consideration of depletion of forest and fishing resources, water pollution, land degradation, air pollution due to metallurgical plants operation, households' environmental protection expenditures, administrative expenditures aimed at environment protection, etc.

However, even the preliminary estimation of environmental costs of economic growth is very useful for recognizing the current role of natural capital in economic growth and for guiding the transition from extensive economic development pattern to economic growth due to increased efficiency of natural resource consumption. Further development of environmental-economic accounts for Ukraine could create a statistical framework needed for the constructive analysis of economic development of Ukraine, which would help to increase the competitiveness of Ukraine's economy in a changing world of limited natural resources.

We can conclude that taking into account the diversity of methodological approaches and substantive role of scientific hypotheses the "Green GDP" cannot yet be directly entered into the system of national accounts. However, the "Green GDP" concept can become a useful tool to assess the environmental and economic policy in the short and long terms, since comparison of environmentally adjusted macroeconomic data and data on final consumption and gross fixed capital formation paves the way for balanced decision making with respect to the sustainability of economic development or conversely for excessive current consumption at the expense of natural resources stocks reduction. Even in the absence of clear and consistent methodology for calculating of the "Green GDP" this concept is based on clear theoretical approaches and is a useful tool not only to demonstrate the effects of economic activities impact on the environment, but also to determine the actual volumes and rates of operation of the national economy. And to enhance the development of the "green" economy in the world

the consideration of the environmental parameters in the system of macroeconomic indicators should become mandatory and should be a component of a balanced socio-economic and political decision making process, enhancing its integration with environmental policy.

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Table 1. Environmentally adjusted macroeconomic aggregates of Ukraine

Data	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Gross Domestic Product of Ukraine										
in current prices, million USD	38009	42393	50133	64881	86142	107753	142719	179992	117228	136419
in 2001 prices, million USD	38009	40346	44135	49605	53031	57819	62210	61019	35163	35956
Net Domestic Product of Ukraine										
in current prices, million USD	31624	35604	42841	56124	76279	96215	128250	163302	103468	121885
in 2001 prices, million USD	31624	33886	37716	42910	46959	51628	55903	55360	31036	32125
Difference between tradional NDP and NDP adjusted for natural resources depletion										
in current prices, million USD	447	470	499	365	1073	1929	3649	6777	2454	4618
in 2001 prices, million USD	447	448	440	279	661	1035	1590	2298	736	1217
Difference between tradional NDP and NDP adjusted for environmental harm due to atmospheric pollution by power plants										
in current prices, million USD	1425	1542	1701	1722	3137	3080	3988	4832	3210	3847
in 2001 prices, million USD	1425	1468	1499	1318	1928	1649	1740	1640	964	1015
Difference between tradional NDP and NDP adjusted for environmental protection expenditures by public sector										
in current prices, million USD	5	15	17	21	28	18	40	38	42	38
in 2001 prices, million USD	5	14	15	16	17	10	18	13	13	10
Environmentally adjusted NDP										
in current prices, million USD	29746	33577	40624	54016	72041	91188	120573	151653	97762	113381
in 2001 prices, million USD	29746	31956	35763	41297	44353	48935	52555	51410	29323	29883
Difference between tradional NDP and environmentally adjusted NDP										
in percents to NDP, %	5,94	5,69	5,18	3,76	5,55	5,22	5,99	7,14	5,52	6,98
Green GDP										
in current prices, million USD	36131	40366	47916	62772	81904	102726	135042	168344	111521	127916
in 2001 prices, million USD	36131	38417	42182	47992	50425	55125	58862	57068	33451	33714
Difference between tradional GDP and environmentally adjusted GDP										
in current prices, million USD	1878	2027	2217	2108	4238	5028	7677	11648	5706	8504
in 2001 prices, million USD	1878	1929	1953	1613	2606	2694	3348	3950	1712	2242
in percents to GDP, %	4,94	4,78	4,43	3,25	4,91	4,66	5,38	6,47	4,87	6,24

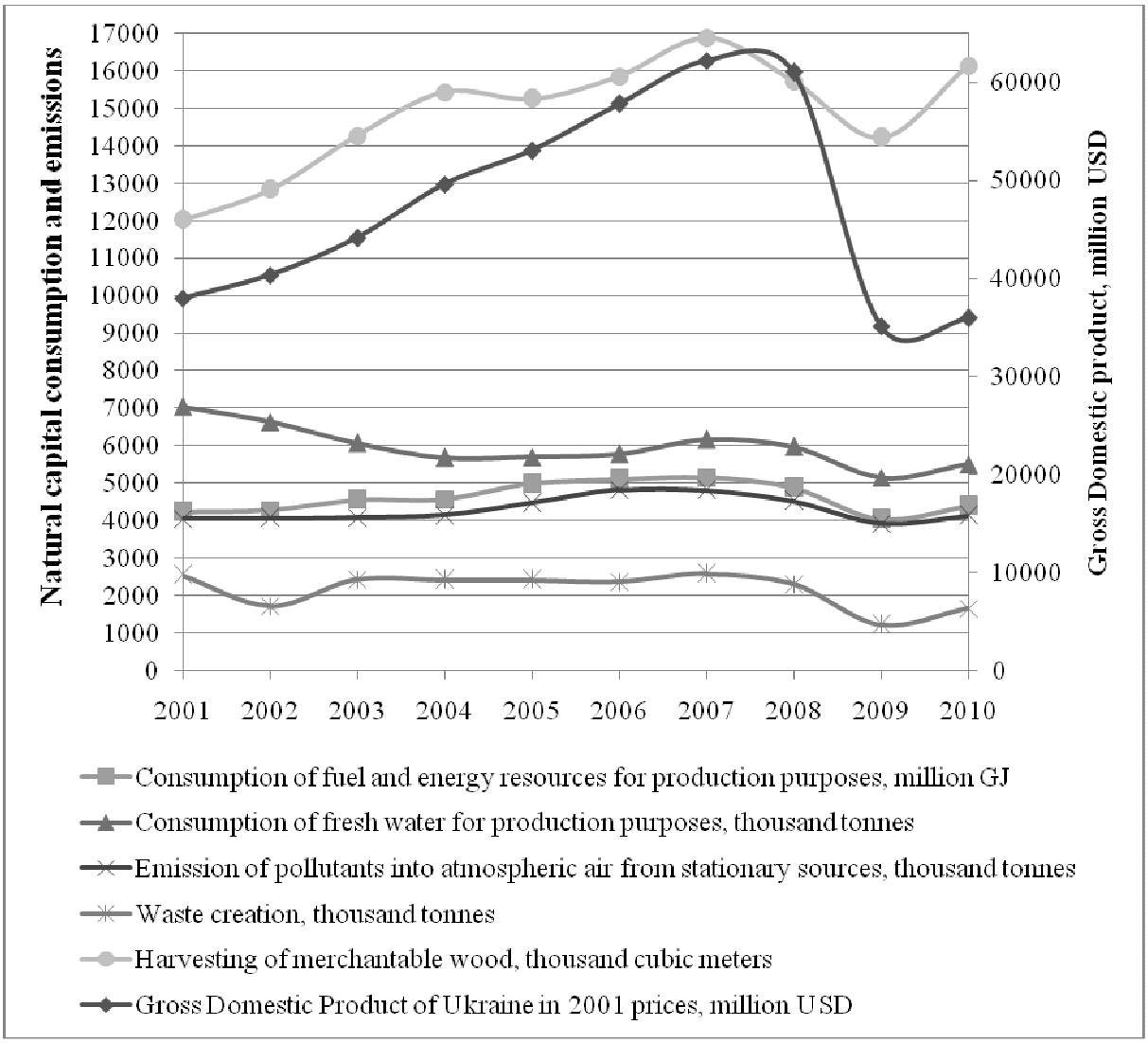

Fig. 1. GDP, natural resource consumption and environmental pollution in Ukraine in 2001-2010.